

# Information

## Clove Cigarettes The Basis for Concern Regarding Health Effects

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*The smoking of clove cigarettes has been associated with 13 cases of serious illness in the United States, including hemorrhagic pulmonary edema, pneumonia, bronchitis, and hemoptysis. We describe a patient in whom, after she smoked a clove cigarette, pneumonia complicated by lung abscess developed. Her lung disease may have been caused by aspiration pneumonia as a consequence of pharyngolaryngeal anesthesia from clove cigarette smoke. Clove cigarettes appeal to adolescents experimenting with smoking practices and may influence the development of later smoking habits.*

(Guidotti TL, Laing L, Prakash UBS: Clove cigarettes—The basis for concern regarding health effects. *West J Med* 1989 Aug; 151:220-228)

A newly popular smoking habit has been developing in the United States.<sup>1,2</sup> Centered in California, this trend involves an exotic tobacco product called clove cigarettes, or "kreteks," a type of cigarette imported from Indonesia containing mixed tobacco and chopped cloves. The use of clove cigarettes achieved the dimensions of a fad in 1985, when imports peaked, but fell off rapidly afterwards due to extensive publicity reflecting concern over their health effects. Since then consumption has remained active at a reduced level amid signs that the major importers and distributors are prepared to make a major push if clove cigarettes were to be vindicated of health concerns. Although the active ingredient of clove, eugenol (4-allyl-2-methoxyphenol), and the popular spice itself have been used extensively in the practices of dentistry and the culinary arts, respectively, adverse health effects have not been reported. With the development of the habit of smoking clove cigarettes, however, several cases of pulmonary diseases associated with this fad have been described. Experimental studies involving animals have not shown pathologic processes akin to clinical findings in humans. The study of clove cigarettes and their implications for health also illuminates the factors that condition adolescent smoking habits, as well as the toxicology of a class of compounds previously of concern only as food additives and spices.

### Availability and Consumption

Nearly all clove cigarettes imported into North America are manufactured by several large companies in Indonesia, where they have been widely used for a century. A small number are manufactured in the United States. In the 1970s, they became popular among young people in Australia and, in about 1980, among teenagers and young adults in southern California. Their earlier popularity among surfers suggests that this might have been the connection that introduced them

into this country. Their popularity in Australia has since waned. Imports into the United States rose from 16 million in 1980 to 150 million in 1984, but fell following adverse publicity in 1985<sup>1,2</sup> and have declined further since (Figure 1).

Popular brands of clove cigarettes include Jakarta, Djarum, Gudang Garam, Krakatoa, Sampoerna "A," and many others, most with Indonesian names. They have been sold in colorful boxes of ten for about \$2.50 in convenience stores, tobacco shops, "head shops," and sometimes drugstores (Figure 2) and are known as "cloves," "kreteks," or "chicartas" by users. Resale among young persons, particularly those younger than the legal age for purchasing tobacco products, is thought to have been a brisk trade in communities where they were popular. In mid-1984, an estimated 70,000 to 80,000 persons smoked them regularly. By 1987, this had fallen to around 25,000 smokers nationwide, of whom about 8,000 were in California. (These figures have been confirmed by the Specialty Tobacco Council, an advocacy organization for the industry.) Many more young people have smoked them on a casual basis. A particular appeal of clove cigarettes has been their identification with a youth-oriented life-style, particularly surfing and "new wave" music, as well as their exotic packaging. Although their sale to minors is forbidden by law, the fad appears to have been widespread among teenagers of high-school age and younger.<sup>1-3</sup> The extent of this fad among youth surprised many adults who were unaware of it until coverage in the news media in 1984 and 1985 gave it visibility.

We collected data on the extent of usage and trends in the penetration of this fad among young people in San Diego in 1982.<sup>4</sup> Our survey of 23 tobacco stores in San Diego indicated that 15 sold clove cigarettes; most of those that did not were small newsstands. Most specialty tobacco stores in the area reported that clove cigarettes were then among their most profitable products. By 1984, convenience stores in

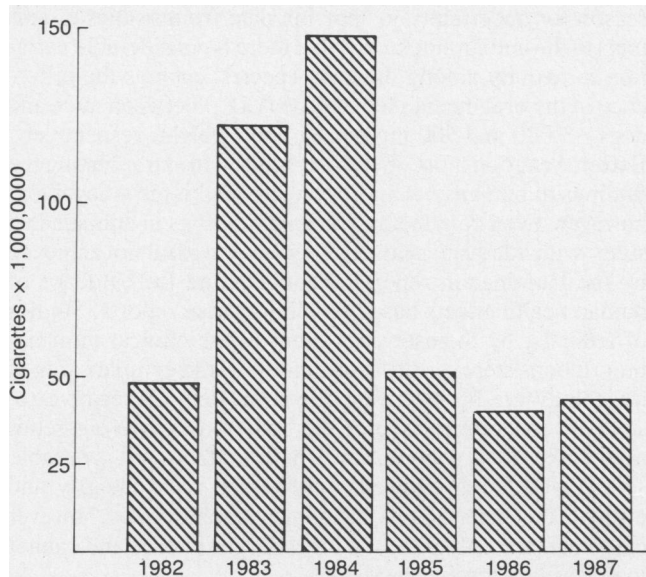
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southern California also carried clove cigarettes, and anecdotal reports suggested that such operations were the major source for teenagers, including minors. Convenience stores now, according to industry sources, have discontinued sales for the most part, and by late 1987 only 5% were estimated to handle the product.

Aside from marketing surveys that are not circulated outside the industry, the most precise estimate of clove cigarette consumption for a defined population is that derived by Robinson and co-workers in an extensive survey of substance use among adolescents aged about 16 years in northern California under conditions of anonymity and isolation from school authorities.<sup>3</sup> Their data are summarized in Table 1. In this study of almost 1,300 predominantly white tenth graders, 20% of the boys and 26% of the girls indicated that they had at least experimented with clove cigarettes, and about 1% of each smoked them on a daily or near-daily basis. Among adolescents who use one or more substances daily, about 12% smoked clove cigarettes. Anecdotal evidence suggests that the use of clove cigarettes among adolescents who use at least one substance daily is almost always in addition to another habit, most likely the consumption of tobacco ciga-



**Figure 1.**—The graphs show the imports of clove cigarettes into the United States from Indonesia since 1982 (from the US Department of Treasury, Bureau of Alcohol, Tobacco, and Firearms).



**Figure 2.**—Clove cigarettes are sold in small, brightly colored packages with exotic designs.

rettes or alcohol. This study showed clearly that clove cigarette use is part of an overall pattern of substance abuse that includes tobacco in other forms, marijuana, and alcohol and that this substance use is related to self-destructive and health-related risk-taking behaviors and poor performance in school. These associations were complex in their interrelationships, and clove cigarettes were but one small piece of the larger picture.

### Composition and Toxicology

Clove cigarettes are made from tobacco compounded with about 30% to 40% minced cloves and have a pungently sweet odor and taste. The mode of smoking among younger smokers often resembles that used for marijuana cigarettes ("toking"). In this practice, a deep inspiration followed by a Valsalva maneuver maximizes delivery to the respiratory surface. How widespread this practice may be is not known, but anecdotal reports suggest that toking is fairly common among American users—possibly in mimicry of marijuana use—but not in Indonesia, where clove cigarettes are smoked in a conventional manner.

In considering the potential toxicity of clove cigarettes, it is useful to think of them as a product with all the known hazards of tobacco cigarettes, with the addition of unknown hazards associated with the chemical constituents of the clove.<sup>5,6</sup> Clove cigarettes deliver a higher tar content than most domestic American brands, although users usually do not smoke them as often as they would conventional cigarettes.<sup>2</sup> Tar deliveries range from 34 to 65 mg, nicotine from 1.9 to 2.6 mg, and carbon monoxide from 18 to 28 mg per cigarette. The high deliveries are probably due to a combination of four factors: the nature of the Indonesian tobacco used, the high weight of the cigarettes, the number of puffs required to consume them, and the tar residues left by the clove bud. Much of the smoke derived from a clove cigarette is a simple distillation of clove oil, without oxidation of the constituents. Indeed, the composition of distilled clove oil—as obtained by the combustion of a 100% clove cigarette—has been called "amazingly simple" and consists primarily of eugenol and related compounds (Figure 3).<sup>7</sup> Five compounds not previously reported in tobacco smoke at comparable levels have been identified in the particle phase of the clove cigarette smoke using gas chromatography and gas chromatography-mass spectrometry: eugenol, acetyl eugenol,  $\beta$ -caryophyllene,  $\alpha$ -humulene, and caryophyllene ep-

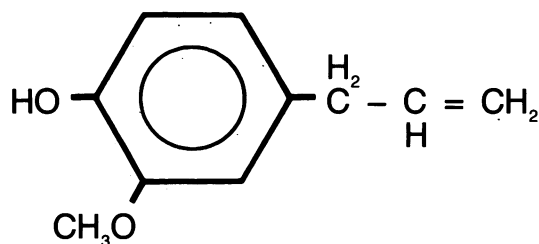
**TABLE 1.**—Clove Cigarette Use by 10th Graders in Northern California in 1985\*

Characteristic	Boys	Girls	All Subjects
Respondents, No. . . . .	677	609	1,286
Use clove cigarettes, %			
Never . . . . .	72	63	68
At least once . . . . .	20	26	23
Frequency of current use, %			
At least monthly . . . . .	7.4	9.9	8.6
Daily or almost daily . . . . .	1.0	0.8	9.1
Frequency of current use (%) among those who used one or more substances daily† . . . . .	NA	NA	12

NA = not available

\*From Robinson et al.<sup>3</sup>

†71% smoked conventional cigarettes, 20% smoked marijuana, 7% drank alcohol, and 4% consumed chewing tobacco or drugs of various types.



**Figure 3.**—The chemical structure of eugenol (4-allyl-2-methoxyphenol) and related compounds is shown.

oxide. All of these compounds have also been identified in natural clove oil.<sup>2,7</sup> These phenylpropene compounds are present at high concentrations in clove and nutmeg. Traces of eugenol are also found in conventional cigarettes. Conventional cigarettes painted with clove oil produce a similar smoke, with a somewhat lower delivery of eugenol and related compounds.<sup>7</sup>

Eugenol has a variety of pharmacologic and toxicologic effects (Table 2).<sup>2,8-16</sup> Clove oil is used extensively and safely as a topical dental anesthetic. This anesthetic activity may also cause numbing of the pharynx when clove cigarettes are smoked. Eugenol and its derivatives are being investigated for their effects on the central nervous system, especially as anticonvulsants. The neurotoxic effects of eugenol are particularly interesting because clove cigarette smoke is thought by many users to have a mild psychotropic effect.<sup>17-19</sup> Adolescent users often report that smoking clove cigarettes confers mild euphoria. It is reasonable to suggest that the relatively high concentration of eugenol likely absorbed by the inhalation route may be a euphoriant. The high nicotine level delivered may also contribute to the euphoric effect.

Before the clove cigarette issue emerged, toxicity testing of eugenol was limited to ingestion or topical application. Only one study assessed pulmonary injury. In this study, the intravenous administration of a dose of 0.1 ml per kg body weight was reportedly associated with the development of pulmonary edema and death in dogs, but detailed data and pathologic descriptions were not available.<sup>20</sup>

More recently two series of studies have become available.<sup>6</sup> In a preliminary study, LaVoie and associates at the American Health Foundation of Valhalla, New York, report that the intratracheal instillation of eugenol at levels not far above those achievable by smoking clove cigarettes resulted in massive acute hemorrhagic pulmonary edema.<sup>21</sup> Studies of the direct inhalation of clove cigarette smoke conducted by the Huntingdon Research Centre in Britain concluded that

exposure to clove cigarette smoke in rats was associated with no greater detectable lung injury at 24 hours and at 14 days than exposure to commercial American cigarettes, however.<sup>22-25</sup> This study reported a lower delivery of carbon monoxide than that suggested by other analyses,<sup>22,23</sup> such as those done at the Oak Ridge (Tennessee) National Laboratory.<sup>26</sup> No study has addressed long-term effects.

All studies done to date on the toxicity of kretek smoke and its components suffer from problems of design and interpretation. A general problem is a doubtful statistical reliability due to the small numbers of animals tested. The statistical power of a study with only five animals per group, as in some of the Huntingdon studies, is low indeed. None of the studies replicate the pattern of kretek use by smokers and cannot address the problem in a way that is convincingly relevant to the clinical cases provided to date and to reports by kretek users. The pattern of kretek smoking cannot be easily duplicated in animal studies without controlling the airway and forcing oral delivery of the smoke in a variety of smoking patterns. In this regard, the inhalation studies are as unphysiologic as the intratracheal instillation experiments despite the known drawbacks of the latter technique. Another reason for uncertainty in applying data from studies of animals to the human situation is that there is considerable variation in toxicity among different species, such as the difference in the oral median lethal dose ( $LD_{50}$ ) between mice and dogs—3,000 and 500 mg per kg body weight, respectively. Extreme caution must, therefore, be used in extrapolating the findings to humans.<sup>6</sup> A more fundamental issue is involved, however. Even convincingly normal findings in animals in a study with adequate statistical power—an ideal not achieved by the Huntingdon reports—cannot refute the evidence of human health effects based on clinical case reports. Studies of animals, by themselves, cannot refute clinical information. Inconsistent results in an emerging and complex area of toxicology are by no means the equivalent of negative results. A coherent picture of the toxicity of clove cigarettes must take into account information from all available sources, including clinical reports, and must identify and evaluate the uncertainties and gaps. Animal studies, however elaborate, are only part of a much larger picture and cannot in themselves resolve the issue.<sup>6</sup>

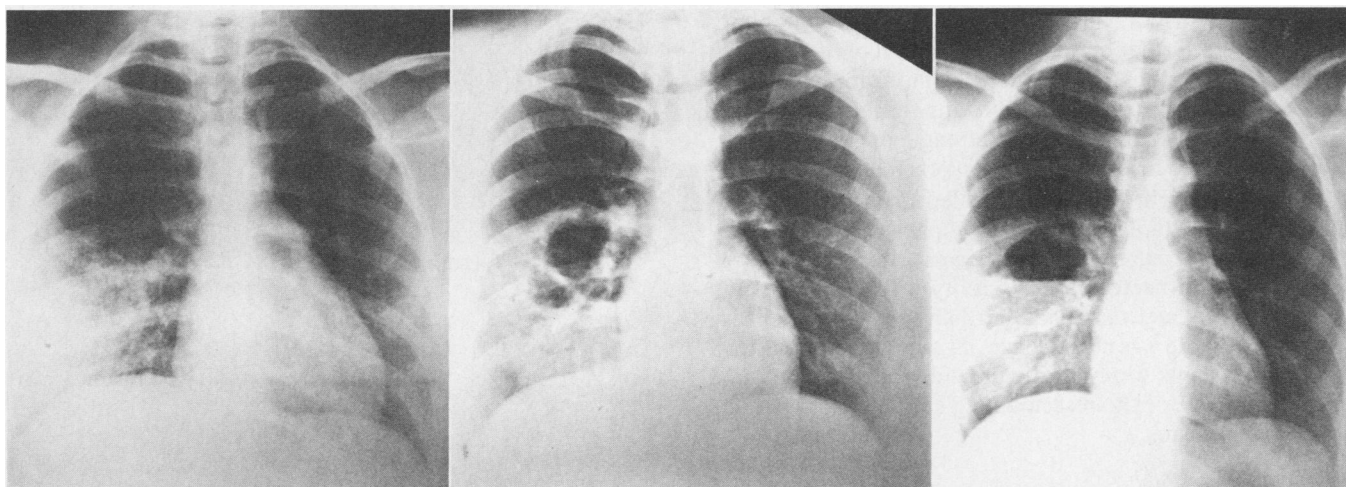
## Human Health Effects

### Illustrative Case Report

An 18-year-old female college student was admitted to a local hospital in May 1985 with an initial diagnosis of acute pneumonia. Her medical history included a single episode of

**TABLE 2.**—Some Known Effects of Eugenol\*

Effect	Exposure	Degree of Effect
Anticonvulsant activity following electroshock	211 mg/kg IP, mice	Potent; transient
Anesthetic	200 mg/kg IP, mice	Potent, dose-dependent
Inhibition of neuronal transmission	0.01%; isolated	Potent; reversible within 3 h
Inflammation	0.1 ml, 100% solution SC, rat	Affected by additives
Sensitization	0.5% to 10% topically, guinea pig	Weakly sensitizing
	0.1% intradermally, guinea pig	Weakly sensitizing
	5% patch test; 155 patients with contact dermatitis	2.6% had allergic reaction
Hypertension, redistribution of regional perfusion, and reduced myocardial contractility	0.05 ml or more IV, dogs	No change in heart rate or electrical activity
IP=intraperitoneally, IV=intravenously, SC=subcutaneously		
*From Guidotti et al, <sup>2</sup> Vishteh et al, <sup>9</sup> Hume, <sup>10</sup> Kozam, <sup>11</sup> Isaacs, <sup>12</sup> Rasheed et al, <sup>13</sup> Cotmore et al, <sup>14</sup> Barkin et al, <sup>15</sup> and McCarter. <sup>16</sup>		



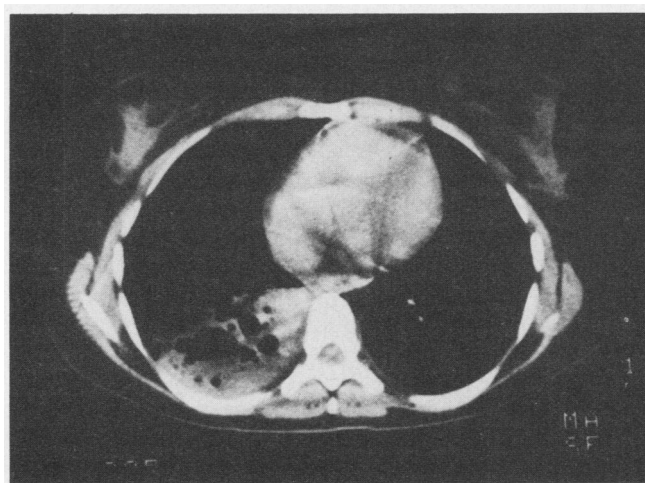
**Figure 4.**—Left, A chest roentgenogram at the time of admission to hospital shows dense pneumonic infiltrates in the right lower lobe. Middle, A chest roentgenogram taken 17 days later shows several air-fluid levels (cavities), a dense infiltrate in the right lower lobe, and partial clearing of the lateral aspect of the right lower lobe. Right, A chest roentgenogram taken 24 days after the initial film shows a large abscess in the right lower lobe.

seizure at age 2, pneumonia diagnosed at age 3, and mild thoracic scoliosis noted at age 10. There was no history of epilepsy, alcohol abuse, bulimia, dysphagia, aspiration, recurrent pulmonary infections, or immunodeficiency disorders. She had smoked an average of two cigarettes per day for six months, including an occasional clove cigarette "for a change." She said she did not use alcohol or drugs except for a few instances of experimenting with marijuana. She said she had not taken any other form of drugs or any medication. About two weeks before her present ailment began, she noted a sore throat, cough, anorexia, and malaise. Most of her symptoms resolved over several days without specific treatment. After completing her university examinations, she drove home to her parents and went to bed around midnight after eating a cheese sandwich. Just before retiring, she smoked a single clove cigarette in her bedroom and, within an hour, she had nausea and vomiting. The next morning, she was lethargic and acutely ill with severe nausea, vomiting, fever, and cough with streaky hemoptysis. She was taken to the local hospital in the evening when the family returned and found her still in bed, feverish, and somewhat incoherent.

On admission, she was observed to be in a toxic condition and in acute respiratory distress with a temperature of 38.8°C (102°F). Minor epistaxis, severe cough, diarrhea, and abnormal lung sounds in the right lower lobe were noted by the admitting physician. The total leukocyte count was  $47.5 \times 10^9$  per liter (47,500 per  $\mu\text{l}$ ) with 0.93 polymorphonuclear leukocytes. A sputum Gram's stain showed gram-positive cocci, but culture of sputum and blood specimens showed no growth. Serum titers for antibody against *Legionella* species were negative, as were cold agglutinins and a mononucleosis spot test. An initial chest roentgenogram showed a pneumonic infiltrate in the right lower lobe (Figure 4, left). A presumptive diagnosis of pneumococcal pneumonia was made, and she was treated initially with a regimen of intravenous cephalothin sodium, tobramycin, erythromycin, and corticosteroids. About a week later, her temperature had returned to normal and the total leukocyte count was  $13 \times 10^9$  per liter (13,000 per  $\mu\text{l}$ ), but the progression of the pneumonic process on a chest roentgenogram (Figure 4, middle) had prompted the addition of nafcillin sodium and clindamycin. Despite aggressive and clinically appropriate management, the pneumonic infiltrate evolved, on the 24th

day after admission, into many areas of cavitation involving the right lower lobe (Figure 4, right). A computed tomography of the chest confirmed the multilobulated areas of cavitation (Figure 5).

On the 29th hospital day, she was transferred to the Mayo Clinic (Rochester, Minnesota) for definitive treatment of the right lung process. An examination disclosed that the patient was afebrile, stable, and coughed intermittently with the production of small amounts of yellowish sputum. Increased vocal fremitus and a combination of bronchial breath sounds and diminished lung sounds were noted in the right lower lobe area posteriorly. There was no lymphadenopathy or hepatosplenomegaly. Blood tests showed the following values: hemoglobin, 6.33 mmol per liter (10.2 grams per dl); total leukocyte count,  $10.1 \times 10^9$  per liter (10,100 per  $\mu\text{l}$ ) with 0.75 neutrophils, 0.11 lymphocytes, 0.08 monocytes, and 0.05 eosinophils; and an erythrocyte sedimentation rate of 102 mm per hour. A blood gas analysis while the patient breathed ambient air showed the following: arterial oxygen tension 87 mm of mercury, carbon dioxide tension 42 mm of mercury, and pH 7.41. A sputum culture was negative. On bronchoscopy there were no endobronchial abnormalities, and protected catheter brush specimens were also negative for bacterial growth. Treatment with cefazolin sodium, mez-



**Figure 5.**—Computed tomography of the thorax shows a pneumonic process in the right lower lobe posteriorly with many air-fluid levels.



locillin, clindamycin, and chest physiotherapy was continued, with no further drainage or resolution of the abscess cavity. A right lower lobectomy was done, from which her recovery was uncomplicated. Following discharge, the patient steadily regained most of her strength and stamina but notes a diminished reserve on strenuous exercise.

The resected right lower lobe revealed many abscess cavities with adjacent areas of organizing pneumonitis (Figure 6). On histologic examination there was a thick-walled abscess cavity with necrosis of the cavity wall with adjacent areas of alveolar atelectasis and intra-alveolar macrophages (Figure 7). \* There was no evidence of granulomata or vasculitis. Special stains were negative for fungi or other organisms, and culture of the resected lung specimen showed no growth of organisms.

#### Comment

In all, 13 cases of severe illnesses possibly associated with clove cigarette smoking were reported to the Centers for Disease Control and the California Department of Health Services by mid-1985 (Table 3). † Eleven were presented in the early published reports.<sup>1,2</sup> The first case in which an association with clove cigarettes was suspected was recognized by Frederick G. Schechter, MD, of Whittier, California, who continues to make important contributions to our understanding of this issue. The 13th case is that of a 20-year-old woman in Hawaii in whom bronchospasm developed hours after she smoked a clove cigarette, but the condition resolved itself. Details on that case are sketchy, as it was not fully investigated (J. W. Stratton, MD, California Department of Health Services, oral communication, March 1988).

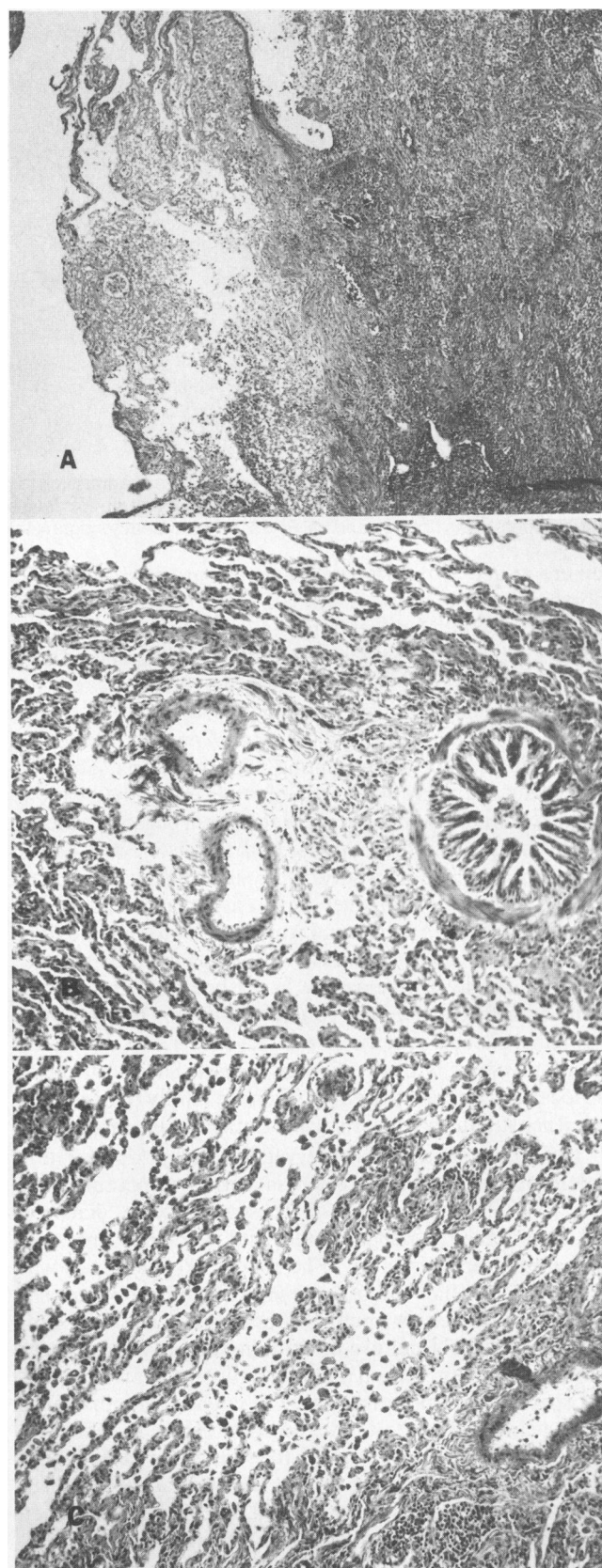
The predominant clinical characteristics among the reported cases (Table 3) have included acute hemorrhagic pulmonary edema or an extensive pulmonary infiltrative process resembling the adult respiratory distress syndrome, followed by death in two. Acute respiratory disorders of this type are extremely rare in previously healthy young people. Even though the mechanisms for the pulmonary disease are not understood, the following should be considered: Eugenol is known to diminish lymphocyte response, macrophage

\*The pathologic and histologic details were provided by Herbert M. Reiman, MD, Section of Surgical Pathology, Mayo Clinic, Mayo Foundation, and Mayo Medical School, Rochester, Minn.

†James W. Stratton, MD, and James Collins, MD, of the California Department of Health Services provided useful information on cases identified to date.



**Figure 6.**—The gross appearance of the resected right lower lobe shows cavitated abscess formation and adjacent organizing pneumonitis.



**Figure 7.**—A, The wall of an abscess cavity is shown, with necrosis of the wall and organizing pneumonitis in adjacent lung tissue ( $\times 64$ ). B, Essentially unremarkable small bronchiole and pulmonary vessels are seen in atelectatic lung and the area of pneumonitis ( $\times 160$ ). C, Intra-alveolar macrophages are shown that may be due to the adjacent pneumonitis ( $\times 160$ ; all three slides were stained with hematoxylin and eosin).

TABLE 3.—13 Suspected Cases of Adverse Health Effects Due to Clove Cigarettes

Clinical Characteristic	Cases, No.
Sex distribution, male:female	8:5
Median age (range), yr	18.5 (11-35)
Antecedent conditions	
Upper respiratory tract infection	5
Asthma	2
Presentation	
ARDS-like symptoms	5
Infection	3
Bronchospasm	2
Aspiration	1
Other	2
Outcome	
Resolved	7
Died	2
Lobectomy	2
Problem persists	1
Lost to follow-up	1

ARDS=adult respiratory distress syndrome

function, and neutrophil chemotaxis in animals.<sup>9</sup> Smooth muscle contraction is inhibited by eugenol,<sup>10</sup> and it may interfere with the tracheobronchial mucus-clearing mechanism and thus stimulate retention of secretions and subsequent pneumonia. Eugenol is known to diminish the contractile force of cardiac muscle, but no direct cardiac toxicity has been found.<sup>20</sup>

Other mechanisms that may interfere with the respiratory function include depression of the central nervous system<sup>11,12,18,19</sup> and respiratory inhibition by an uncoupling of oxidative phosphorylation and inhibition of the cyclooxygenase pathway.<sup>13,14,19</sup> The rapidity with which the pulmonary disease developed in the reported cases, however, argues against these factors being primarily responsible for the acute pulmonary process. Although the possibility exists of these mechanisms in prolonged illness, it was unlikely, at least in our patient, because there have been no reports of chronic pulmonary disease following clove cigarette smoking. The clinically significant factors most likely to be responsible for the pulmonary disease include the potential of eugenol to irritate the bronchi directly, with resultant hemoptysis, direct alveolar damage leading to hemorrhagic pulmonary edema, and aspiration pneumonia as a result of eugenol-induced pharyngolaryngeal anesthesia, nausea, and vomiting. In two other cases,<sup>1,2</sup> as well as in our patient, the clinical picture strongly suggested aspiration pneumonia; these three patients are known to have smoked clove cigarettes before going to bed, and their histories were highly suggestive of aspiration. The deglutition and swallowing response in humans is a complex mechanism, easily interfered with by factors that alter local reflexes, voluntary swallowing, and pharyngeal sensation. The topical anesthetic effect of eugenol is likely to have such effects.<sup>6</sup>

In another case, acute epiglottitis occurred, showing the potential for upper airway lesions to occur that may be associated with the possibility of aspiration. Hemoptysis to a minor degree and bronchitis are also frequently reported by clove cigarette users,<sup>1</sup> likely the result of direct irritation of bronchial mucosa by clove cigarette smoke. Life-threatening acute toxic effects appear to be uncommon, given the number of users, and may reflect the presence of other factors; sev-

eral patients are known or thought to have had viral infections preceding the event. Our patient had an antecedent viral-like illness and streaky hemoptysis.

The sporadic and infrequent occurrence of a major pulmonary effect of kretek smoke on the lungs of young adults might also be explained by a previous sensitization to eugenol. Eugenol is known to modify cellular immune responses and to induce allergic reactions in sensitized persons.<sup>15,16</sup> Available clinical evidence suggests that the major acute adverse health effect of kreteks is an idiosyncratic or hypersensitivity-mediated inflammatory process, occurring infrequently and unpredictably following normal use. The sporadic nature of the reports suggests that host factors may play a role in determining individual susceptibility. Nevertheless, clove cigarettes are unequivocally a health hazard to all users. They are tobacco-containing cigarettes, and the health hazards associated with smoking are well known.

The long-term effects of smoking clove cigarettes above those caused by the tobacco are unknown. Cancer and chronic lung disorders are the most likely candidates, but the risk of either cannot be evaluated directly because the data is too new. The possible cancer risk associated with clove cigarettes, above that of conventional cigarettes, is not known. The International Agency for Research on Cancer has reviewed the evidence for the carcinogenicity of eugenol and has concluded that there is limited evidence for an effect in animals but that no epidemiologic data are available to evaluate the possible risk to humans.<sup>8</sup> Tests of eugenol in short-term assays of potential carcinogenicity suggest that the compound may be active in cell types more closely resembling mammalian cells but not in bacteria. Because previous assays for mutagenic activity were done in bacterial systems, such findings contradict early negative reports and have implications for human exposure.<sup>2,8</sup> The appropriate studies in animals have not yet been done. What is known regarding this family of compounds is disturbing, however. Eugenol is closely related to safrol, a weak hepatic carcinogen. Methyl-eugenol is a suspected carcinogen in animals where studies suggest the potential of eugenol to be a human carcinogen even though eugenol, as used in dentistry and as a spice, has not been shown to cause cancer.<sup>8</sup> The essential issue is whether the risk to health that its use in smoking confers is substantially greater than that of conventional cigarettes. Studies in Indonesia, where clove cigarettes have been used for many years, have not been done and would be of questionable usefulness, both because of differences between the health reporting systems of the two societies and because the nearly exclusive use of clove cigarettes there would make comparisons with other smoking habits difficult.

### Behavioral Effects

Much of the concern about clove cigarette use is related to the spread of the habit among subgroups of adolescents who are highly subject to peer influences and prone to experiment with tobacco and other substances. The early experiences that condition later cigarette smoking habits have not been well studied, in part because any such study would of necessity require at least the passive tolerance of young people smoking. In the absence of meaningful data beyond consumption patterns, we might expect that clove cigarettes would engage young smokers in the habit more easily than conventional cigarettes. The exotic appeal, strong aroma, and peer interest in the product would be factors, especially

given the early image of clove cigarettes as a healthy alternative to conventional cigarettes.

The clove cigarette is nearly ideal in design as a "trainer" cigarette for capturing young people as smokers. This has serious implications for the future smoking habits of users. Behavioral effects may be direct, as in the possible central effects of eugenol, or indirect, as they influence health-related behavior. Both may play a role in any effect of the clove cigarette habit on cigarette smoking when the subjects are young. The initial smoking experience with clove cigarettes is not always pleasurable to mature adults because the taste and odor are overwhelming. Adolescent users report that they prefer clove cigarettes to regular ones, however, and that they perceive clove cigarette smoke as smoother, despite the perceived harshness of the tobacco used and the higher content of tar. The effects of eugenol may also blunt the aversive conditioning associated with the initial response to ordinary cigarettes. Drugs that produce mild euphoria or other pleasurable effects could condition a more compulsive smoking habit. A single clove cigarette may deliver a substantial amount of eugenol to the alveolar surface, where absorption into the bloodstream is rapid and efficient. The central pharmacologic effect of the nicotine, possibly modified by an effect of eugenol, could be pleasurable to immature youths. As a "safe" and easily accessible alternative to marijuana and hard drugs, clove cigarettes may be a titillating way for adolescents to appear daring and "in" with their peer group without taking what they might perceive as the greater and frightening risk of illicit drugs. Our patient, discussed earlier, was introduced to clove cigarettes by a fellow dormitory resident at university seven months before her illness. She obtained a package of 20 clove cigarettes in a local shopping mall for \$2.50. Her smoking habits started with her entry into university, where she was a good student and moderately athletic. She was evaluated as having good self-esteem and had no history of marginal or antisocial behavior. No reports of a physical or aberrant psychological dependence on clove cigarettes have yet appeared.

Few studies have examined psychological variables in relation to adolescent smokers. Palmer studied 3,000 junior high school students in South Dakota and Iowa in 1965<sup>27</sup> and found that for adolescents or preadolescents the first experience with smoking seemed to be the crucial one. Solitary experimentation was rare, especially among those who became regular smokers. By age 12, most boys who wanted to smoke had already done so, and among girls, most had tried by age 14. Most of Palmer's subjects reported feeling "nothing" when they smoked their first cigarette. Those who became regular smokers more often reported that they enjoyed smoking, but those who remained only experimental smokers expressed feelings of sickness or shame. Hunter and colleagues found that the number of people who smoked in a child's environment seemed to influence trial behavior, as did beliefs about the rewards of smoking.<sup>26,28</sup> About half of those who started smoking before age 12 smoked their first cigarette with a family member or an old friend. After age 14, the initial experience occurred more often with peers. We might therefore predict that the faddish nature of clove cigarettes may enhance the social influence of experimentation, and the more acceptable taste and anesthetic effect of clove cigarettes may make the first experience with smoking more enjoyable.

Bewley and co-workers confirmed the importance of the

initial cigarette experience on later behavior.<sup>29</sup> Of the current smokers, 21% reported enjoying their first cigarette; only 3% of the nonsmokers reported that they expected to enjoy their first cigarette. Two thirds of the nonsmokers expected to be sick. Only 32% of the smokers reported feeling sick on their first encounter, however. Young people with a lower threshold for nausea induced by nicotine are more likely to have an aversive sensation on first smoking and may seek a more acceptable initial experience. Clove cigarettes may spare this group the aversive initial experience they might otherwise have with their early smoking experiments.

Robinson and associates characterized clove cigarette use among adolescents in northern California as part of a larger pattern of substance use, social maladjustment, and maladaptive behavior.<sup>3</sup> They found that two of the strongest predictors of substance use among adolescents were peer social pressure and an attitude that cigarette smoking is acceptably safe. They reported that peer social pressure and a dismissive or rejecting attitude toward the health consequences of smoking were correlated with levels of substance use. Both factors are operating in the case of clove cigarettes.

The false image of the product as clean, natural, and safer than conventional cigarettes seems to attract some young people who would otherwise not start smoking and who are not part of the subgroup of adolescents with problem behaviors. The strong identification of clove cigarettes with trendy music, youth-oriented life-styles, and the exotic adds a cultural dimension of group behavior and peer pressure among young people. How this initial, strongly positive encounter with cigarettes will affect their later smoking habits is a matter of conjecture. No studies are known to be underway to document such an effect. This is doubly unfortunate because such studies might help us to understand the motivations and practices of young smokers just starting the cigarette habit in general as well as the dynamics of clove cigarette use.

### Regulation and the Media

Reflecting an early local recognition of the fad, the American Lung Association of San Diego and Imperial counties was the first agency to issue a public statement on the possible health risks associated with clove cigarettes. This was part of a 1982 policy document on cigarette additives.<sup>5</sup>

In December 1988, the Council on Scientific Affairs of the American Medical Association released its own review of the evidence for health effects. The report recommended that "since the American Medical Association has an existing policy vigorously opposing the use of any tobacco product, this policy should now be extended to include explicit opposition to the use of clove cigarettes. Further, it is recognized that smoking clove cigarettes may present an additional hazard to susceptible individuals."<sup>30</sup>

The fad received considerable publicity in the national media in 1984 and 1985 because of the concern over acute ill effects. In addition to heavy coverage by local news media, particularly in southern California, articles appeared in several national publications, including *Time* magazine ("Clove Smokers: Danger in a Teen-age Fad?" January 17, 1985, p 63), *The Wall Street Journal* (S. P. Galante: "Clove Smokers: Pure Puffing or Health Hazard?" June 3, 1985, p 23), and *Consumer Reports* ("Beware Those Spicy Cigarettes," November 1985, p 641), and the issue has been broadcast on network radio and television, including the NBC "Today" show and "Good Morning America." Sales of the cigarettes

have fallen in this country since the beginning of 1985, when publicity over the risk to health reached a high point.

The Specialty Tobacco Council is an organization of the principal manufacturers and distributors of clove cigarettes. Based in North Carolina, with an information office in Los Angeles, this organization has distributed information representing the industry's point of view to the media, has represented the industry in legislative matters, and sponsored the Huntingdon studies, reportedly anonymously to avoid charges of bias. The Specialty Tobacco Council maintains a professional staff and legal counsel and has been aggressive in challenging those calling the safety of clove cigarettes into question.

In the United States, regulatory options for tobacco products are limited. These products are not subject to the same requirements of safety and quality control as food, cosmetics, or drugs. The advertising of all tobacco products (including clove cigarettes) is regulated by the Federal Trade Commission, and each packet must carry the Surgeon General's warning. Since October 1985, the US Department of Health and Human Services has required manufacturers and distributors of tobacco products to report any additives, including natural materials such as cloves, so that it can monitor threats to health. There is no federal legislation that authorizes the restriction of imports or a nationwide banning of sales of a tobacco product, even in the face of a demonstrable hazard to health. The federal government has only the most tenuous authority over tobacco products.

New Mexico, Maryland, Nevada, and Utah have banned the sale of clove cigarettes. Other states have considered such a ban. In Florida a ban was overturned on constitutional grounds after it was passed by the legislature. In California, where the fad began in North America and where it still appears to be most entrenched, the legislature chose not to ban clove cigarettes—as provided for in Assembly Bill 2559, 1985—but to appoint a scientific advisory board to review the evidence and to advise the legislature on possible adverse health effects (Assembly Bill 2559, enacted, October 1985). That board has now completed its deliberations and in October 1988 recommended “strongly” a complete ban on their sale in California as “the most practical and most effective way” to deal with the problem.<sup>31</sup> The board observed that there was no substantial issue of balancing costs against benefits because there were no health or social benefits of consequence to be considered. The role of the states in this matter is complicated by several factors, including the jurisdiction of state and local governments in this area of primarily federal concern, the degree of hazard of clove cigarettes compared with that of ordinary cigarettes (a proven lethal commodity), and the validity of the concept of informed assumption of risk that underlies US regulatory policy with respect to tobacco products, particularly as it may be construed in relation to products consumed by teenagers. The issue of clove cigarettes, far from being a unique and transient concern, has raised fundamental questions about the regulation of tobacco products.

## Conclusions

There is not much known for certain about the health effects of clove cigarettes. Given the decline in popularity of the product, it is entirely possible that important issues may never be resolved. For purposes of public policy and the

protection of the public interest, however, the following conclusions can be drawn:

- There is evidence to suggest that some persons may be at risk for rare but severe respiratory effects. A larger proportion of users may experience minor health effects, particularly hemoptysis. The characteristics that might predict the occurrence of these outcomes in a healthy adolescent are unknown.
- The indirect effects of clove cigarettes may involve mild central effects, behavioral aspects of using the product, and the local anesthetic effect of eugenol on the upper airway. They are likely to have the effect of conditioning a later smoking habit among adolescents who use clove cigarettes to initiate their experiments with smoking.
- This product has been associated in the past with questionable sales practices that have had the effect of promoting smoking among adolescents. The products have also had a misleading image of safety and “herbal” properties.
- The long-term effects of the product cannot be evaluated because of the short duration of the fad in North America and Australia and the impossibility of controlling for the many other influences on health studies in societies where clove cigarette use is common. The carcinogenic potential of clove cigarettes is apparently at least as great as that for conventional cigarettes.
- Given that clove cigarettes are an utterly dispensable habit, carry a risk at least as great as that of conventional cigarettes, and are most heavily used by young people at risk of incurring a permanent smoking habit, the use of the product should be discouraged. Whether a legislated ban is appropriate depends on the regulatory philosophy, jurisdiction, and legal authority of a state.

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